

## Experience Big Science at Brookhaven National Laboratory

At BNL, students become scientists — exploring the nature of matter and seeking conclusions based on their own data. The Brookhaven experience focuses on making abstract scientific concepts real as students engage in hands-on activities grounded in research done at BNL.

### Students can:

- Explore protein structure in our 3D theater
- Observe evidence of cosmic rays in our cloud chambers
- Experiment with soil remediation techniques developed at BNL
- Design a circuit made of solar panels
- Learn why scientists are investigating materials at the nanoscale

### Middle School Labs

**Column Crushers: An Engineering Challenge** – From the Acropolis to the International Space Station columns have been an integral engineering feature. Participants will be challenged to build and test column load capacity using various instruments including a fatigue testing machine. (3 hour lab)

**DNA Extraction** – DNA is the molecule that carries the genetic blueprint of all living cells. Students learn about the structure and nature of DNA as they extract and collect it from cell samples. This session helps students understand the basic concepts of molecules and the genetic code.

**Fun with Cosmic Rays** – Cosmic rays are all around us. Students assemble cloud chambers, then observe and study particles by analyzing trails left by naturally occurring cosmic rays that regularly shower the Earth. Students are introduced to the world of particle physics, a Brookhaven Lab specialty.

**Gene Transfer and Genetic Engineering** – Genetic transformation is the uptake and expression of foreign DNA by a living cell. Students are introduced to the history of this technology, learn how it continues to develop, and get hands-on experience transferring a gene that can make bacteria glow.

**Graphic Exposure: Clouds and Solar Energy** – Solar energy is a clean, renewable resource, but how is it affected by clouds and cloud systems? Students use laptop computers to answer a research question about clouds and solar energy by visually representing and comparing data sets in a graph.

**LINAC: Ready, Set, Smash!** – Simulate particle collisions in Brookhaven's Relativistic Heavy Ion Collider (RHIC) by creating a model linear accelerator using the attractive force of magnetism and the transfer of energy.

**Introduction to Nanomaterials** – Nano is small and can be found all around us. Engage in hands-on activities designed to provide a greater understanding of the size of a nanometer and how material properties change at that small scale.

### **Nanotechnology: Seeing the Invisible**

– In order to study materials at the nanoscale, scientists need specialized tools. The scanning probe microscope (SPM) is one tool that allows scientists at Brookhaven's Center for Functional Nanomaterials to "see" at the nanoscale. Students will simulate a SPM to gather data to determine the surface of a mystery material.

### **Nanotechnology: Small Things Bring Big Change**

– Scientists have discovered that materials at the nanoscale, measured in billionths of a meter, behave differently than at the macroscale. These differences open the door to new applications in areas such as energy conservation and self-assembling materials. Through hands-on activities, students will learn how properties differ at the nanoscale and explore opportunities that nanotechnology presents. (90 min. lab)

### **"Nowcasting:" Cloud Formation Lab**

– What is a cloud and how do they form? Learn the role aerosols play in cloud formation and why BNL scientists spend their time flying through the clouds to sample the skies. This lab culminates with a cloud modeling activity that students will use to predict, estimate, measure, revise, and record cloud precipitation data.

### **Protein Structural Biology in 3D**

– Proteins are one of the key products of the genetic code. Students examine DNA and protein structures using the same scientific databases as Brookhaven scientists. In our state-of-the-art 3D theater, students also view and generate protein models to explore the relationship between protein structure and function.

**Solar Energy Lab** – Explore the properties of photovoltaic solar panels. By experimenting with a variety of materials, students will determine which materials are ideal for transmission, absorption, and reflection of solar energy.



Long Island STEM Hub Partner  
[www.listemhub.org](http://www.listemhub.org)

## High School Labs

### **Citric Acid Process of Soil Remediation**

– Citric acid, a naturally occurring organic complexing agent, can be used to remove toxic metals from soil. Learn about this molecular technique developed at BNL. Workshop participants follow a simple procedure to remove and recover a metallic "contaminant" by forming a soluble iron-citrate complex. Students use the o-phenanthroline method to analyze the concentration of the iron in the soil. (2 hour lab)

### **DNA Analysis: Cutting DNA with**

**Enzymes** – Cutting DNA from one molecule and pasting it in another is the basis of the "recombinant DNA revolution" and the rapidly expanding field of biotechnology. In this lab, students use the tools of recombinant DNA, called restriction enzymes, to analyze DNA and determine the identity of a bacterial virus. (2 hour lab)

### **Gene Transfer and Genetic Engineering**

– Genetic transformation is the uptake and expression of foreign DNA by a living cell. Students are introduced to the history of this technology, learn how it continues to develop, and get hands-on experience transferring a gene that can make bacteria glow. (2 hour lab)

**Metal Removal by Zeolites** – Zeolites are common minerals found in Earth's crust that play an important role in removing toxic metals and radioactive elements from wastewater. Brookhaven scientists are searching for new materials and techniques to enhance zeolites' ion-exchange reactions. Students perform an ion-exchange-reaction experiment using calcium and iron ions to remove sample "contaminants." (90 min. lab)

		Living Environment	Chemistry	Physics	Earth & Space Sci.	Mathematics	Technology
Grades 5 - 6	DNA Extraction	✓					
	Gene Transfer	✓					
	Graphic Exposure				✓	✓	✓
	Intro to Nanomaterials	✓	✓			✓	
	Nano: Seeing Invisible			✓		✓	✓
	Nowcasting				✓	✓	
	Protein Structural Biology in 3D	✓					✓
	Solar Energy			✓	✓	✓	
Grades 7 - 8	Column Crushers			✓		✓	✓
	Fun With Cosmic Rays			✓	✓		
	Gene Transfer	✓					
	Graphic Exposure				✓	✓	✓
	LINAC			✓			
	Nano: Small Things/Big Change	✓	✓			✓	✓
	Nowcasting				✓	✓	
	Protein Structural Biology in 3D	✓					✓
Grades 9 - 12	Solar Energy			✓	✓	✓	
	Citric Acid Remediation		✓			✓	
	DNA Analysis	✓					
	Gene Transfer	✓					
	Metal Removal by Zeolites		✓				

## Further Information

- Exploration Labs are 1 hour unless otherwise noted
- Fee-based labs are charged per hour
- Maximum class size is 30 students
- Exploration Labs available as outreach to your school
- Visit our website for detailed program information: [www.bnl.gov/education](http://www.bnl.gov/education)

Contact the Office of Educational Programs to schedule your visit: (631) 344-4495